Supercomputing for better commuting—in pursuit of fuel economy and mobility

October 2 2018, by Stephanie G. Seay

A GRIDSMART traffic camera installed at an intersection in Leesburg, Virginia. Credit: GRIDSMART

In a project leveraging computer vision, machine learning, and sensors, Oak Ridge National Laboratory scientists are working with private company GRIDSMART Technologies, Inc. to demonstrate how stop lights can be programmed to improve fuel economy and reduce emissions while facilitating the smooth flow of traffic.

GRIDSMART traffic cameras are already being used by communities around the world to replace in-road sensors traditionally used to detect vehicles and inform traffic signal timing. These smart cameras provide a real-time, bird's eye view of intersections, gathering data that can guide timing and traffic flow strategies.

The goals of the program are to teach GRIDSMART cameras to estimate the fuel efficiency of vehicles at intersections and then to control traffic signal timing in order to save energy while optimizing traffic throughput, explained project lead Tom Karnowski of ORNL's Imaging, Signals, and Machine Learning Group.

The fuel savings potential is substantial. The US Department of Energy estimates that idling from heavy- and light-duty vehicles combined wastes about 6 billion gallons of fuel per year. As vehicles idle at intersections and other locations, fuel is wasted.

The ORNL/GRIDSMART project was one of the first awarded funding under the DOE Vehicle Technologies Office's new High Performance Computing (HPC) for Mobility (HPC4Mobility) program. As part of the HPC for Energy Innovation Initiative, the program brings together the supercomputing resources and scientific expertise of DOE's national laboratories in partnership with industry to find solutions to real-world transportation energy challenges.

Creating an intelligent transportation system in traffic-dense urban areas requires observation beyond human capacity, and the amount of data generated by the GRIDSMART cameras makes it an excellent fit for the HPC4Energy program, Karnowski noted.

"GRIDSMART is excited to be working with ORNL on this project," said Jeff Price, GRIDSMART chief technology officer. "Multimodal urban mobility poses very complicated challenges. Bringing to bear

ORNL capabilities in high-performance computing and machine learning on GRIDSMART's unique data and large install base will provide some fascinating insights."

The first phase for ORNL researchers has been to take images from GRIDSMART's overhead traffic cameras and compare them to ground-level photos to create a database. The researchers want to train the cameras to estimate the fuel economy of various vehicles present at intersections by categorizing their size and vehicle class.

ORNL researchers developed a system to combine the resulting photos with fuel consumption data for different vehicle classes, which resulted in a rich dataset of labeled images.

"Any machine learning project will only be as good as the data you're putting in," Karnowski said.

The second phase of the project is to create a software application by using reinforcement learning on ORNL's supercomputers. Reinforcement learning basically teaches a computer how to play a game without being explicitly programmed to do so. "In this case, the 'game' is saving fuel while not sacrificing throughput," Karnowski said.

The project leverages high performance computing systems at the Oak Ridge Leadership Computing Facility, a DOE Office of Science user facility at ORNL, such as the Summit supercomputer—the world's most powerful openly accessible computer. The systems will be used to perform simulations of intersections and come up with mathematical strategies to guide traffic light timing.

"The whole idea is to teach cameras to estimate fuel consumption and then teach an entire grid of those cameras to manage traffic lights to make the system more fuel efficient," Karnowski said.

ORNL collaborators on the project include Travis Johnston, Thomas Naughton, Wael Elwasif, Jonathan Sewell, Russ Henderson, and Husain Aziz.

"This project is exemplar for how national laboratory high performance computing resources made available through HPC4Mobility can enable U.S. industry to optimize energy efficiency and reduce emissions," said Claus Daniel, Sustainable Transportation program director and HPC4Mobility program lead at ORNL. "We're working hand-in-hand with a private partner to leverage DOE's computing resources and deep learning expertise to solve a real-world mobility challenge—one that will save energy and improve traffic flow."

Provided by US Department of Energy